Chapter 640 Geometric Cross Section

640.01 General

Geometric cross sections for state highways are governed by functional classification criteria, traffic volume, and whether the highway is in a rural or an urban area. (See Chapter 440 for information on functional class.)

High Occupancy Vehicle (HOV) lanes must be considered when continuous through lanes are to be added within the limits of an urban area with a population over 200,000. (See Chapter 1050.)

When a state highway within an incorporated city or town is a portion of a city street, the design features must be developed in cooperation with the local agency. (See Chapter 440 for guidance on geometric design data when a state highway within an incorporated city or town is a portion of a city street.)

For additional information, see the following chapters:

Chapter	Subject
430	Roadway widths and cross slopes for modified design level
440	Minimum lane and shoulder widths for full design level
440	Shoulder widths at curbs
510	Geotechnical investigation
520	Pavement type
641	Turning roadway width
642	Superelevation
910	Requirements for islands
940	Lane and shoulder widths for ramps
960	Median crossovers

640.02 References

Design Guidance

Highway Runoff Manual, M 31-16, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2004

640.03 Definitions

auxiliary lane The portion of the roadway adjoining the through lanes for parking, speed change, turning, storage for turning, weaving, truck climbing, and other purposes supplementary to through-traffic movement.

divided multilane A roadway with two or more through lanes in each direction and a median that physically or legally prohibits left turns, except at designated locations.

freeway A divided highway that has a minimum of two lanes in each direction, for the exclusive use of traffic, and with full control of access.

high pavement type Portland cement concrete pavement or hot mix asphalt (HMA) pavement on a treated base.

intermediate pavement type Hot mix asphalt pavement on an untreated base.

lane A strip of roadway used for a single line of vehicles.

lane width The lateral design width for a single lane, striped as shown in the Standard Plans and the Standard Specifications.

low pavement type Bituminous surface treatment (BST).

median The portion of a highway separating the traveled ways for traffic in opposite directions.

outer separation The area between the outside edge of the traveled way for through traffic and the nearest edge of the traveled way of a frontage road or a collector-distributor road.

roadway The portion of a highway, including shoulders, for vehicular use.

rural design area An area that meets none of the conditions to be an urban design area.

shoulder The portion of the roadway contiguous with the traveled way, primarily for accommodation of stopped vehicles, emergency use, lateral support of the traveled way, and use by pedestrians.

shoulder width The lateral width of the shoulder, measured from the outside edge of the outside lane to the edge of the roadway.

superelevation The rotation of the roadway cross section in such a manner as to overcome part of the centrifugal force that acts on a vehicle traversing a curve.

traveled way The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

turning roadway A curve on an open highway, a ramp, or the connecting portion of the roadway between two intersecting legs of an intersection.

undivided multilane A roadway with two or more through lanes in each direction on which left turns are not controlled.

urban area An area designated by the Washington State Department of Transportation (WSDOT) in cooperation with the Transportation Improvement Board and regional transportation planning organizations, subject to the approval of the FHWA.

urban design area An area where urban design criteria is appropriate, that is defined by one or more of the following:

- An urban area.
- An area within the limits of an incorporated city or town.
- An area characterized by intensive use of the land for the location of structures, that receives such urban services as sewer, water, and other public utilities, as well as services normally associated with an incorporated city or town. This may include an urban growth area defined under the Growth Management Act (see Chapter 36.70A RCW, Growth management – planning by selected counties and cities), but outside the city limits.
- An area with not more than 25% undeveloped land.

640.04 Roadways

The cross sections shown in Figures 640-1, 2, 3, 4a, and 4b represent minimum values for full design level. (See Chapter 440 for additional design information for full design level and Chapter 430 for cross sections and design information for modified design level.)

(1) Traveled Way Cross Slope

The cross slope on tangents and curves is a main element in roadway design. The cross slope or crown on tangent sections and large radius curves is complicated by two contradicting controls. Reasonably steep cross slopes are desirable to aid in water runoff and to minimize ponding as a result of pavement imperfections and unequal settlement. However, steep cross slopes are undesirable on tangents because of the tendency for vehicles to drift to the low side of the roadway. Steeper cross slopes are noticeable in steering, and they increase susceptibility to sliding to the side on icy or wet pavements.

A 2% cross slope is normally used for tangents and large radius curves on high and intermediate pavement types. With justification and a hydraulic analysis, cross slopes between 1.5% and 2.5% are acceptable. Do not design cross slopes flatter than 1.5%.

On low pavement types, the cross slope may be increased to 3% to allow for reduced construction control and greater settlement.

Superelevation on curves is a function of the design speed and the radius of the curve. (See Chapter 642 for guidance on superelevation design.)

(2) Turning Roadways

The roadway on a curve may need to be widened to make the operating conditions comparable to those on tangents. There are two main reasons to do this. One is the offtracking of vehicles, such as trucks and buses. The other is the increased difficulty drivers have in keeping their vehicles in the center of the lane. (See Chapter 641 for width requirements on turning roadways.)

To maintain the desired design speed, highway and ramp curves are usually superelevated to overcome part of the centrifugal force that acts on a vehicle. (See Chapter 642 for superelevation requirements.)

(3) Shoulders

Pave the shoulders of all highways where high or intermediate pavement types are used. Where low pavement type is used, treat the roadway full width.

Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. With justification, shoulder slopes may be increased to 6%. On the high side of a roadway with a plane section, such as a turning roadway in superelevation, the shoulder may slope in the opposite direction from the adjacent lane. The maximum difference in slopes between the lane and the shoulder is 8%. Examples of locations where it may be desirable to have a shoulder slope different than the adjacent lane are:

- Where curbing is used.
- Where shoulder surface is bituminous, gravel, or crushed rock.
- Where overlays are planned and it is desirable to maintain the grade at the edge of the shoulder.
- On divided highways with depressed medians where it is desirable to drain the runoff into the median.
- On the high side of the superelevation on curves where it is desirable to drain stormwater or meltwater away from the roadway.

When extruded curb is used, see the Standard Plans for required widening. Widening is normally required when traffic barrier is installed. (See Chapter 710.)

It is preferred that curb not be used on high-speed facilities (design speed above 45 miles per hour). In some areas, curb may be needed to control runoff water until ground cover is attained to prevent erosion. Plan for the removal of the curb when the ground cover becomes adequate. Arrange for curb removal with regional maintenance as part of the future maintenance plans. When curb is used in conjunction with guardrail, see Chapter 710 for guidance.

Figures 640-5a and 5b represent shoulder details and requirements.

640.05 Medians and Outer Separations

(1) Purpose

The main function of a median is to separate opposing traffic lanes. The main function of an outer separation is to separate the main roadway from a frontage road. Medians and outer separations also provide space for:

- Drainage facilities.
- Undercrossing bridge piers.
- Vehicle storage space for crossing and left-turn movements at intersections.
- Headlight glare screens, including planted or natural foliage.
- Visual separation of opposing traffic.
- Safety refuge areas for errant or disabled vehicles.
- Storage space for snow and water from traffic lanes.
- Increased safety, comfort, and ease of operations.
- Access control.
- Enforcement.

(2) Design

Figures 640-6a through 6c give minimum design requirements for medians. (See Chapters 430 and 440 for minimum median widths.) Median widths in excess of the minimums are highly desirable. When the horizontal and vertical alignments of the two roadways of a divided highway are independent of one another, determine median side slopes in conformance with Figure 640-1. Independent horizontal and vertical alignment, rather than parallel alignment, is desirable.

No attempt has been made to cover all the various grading techniques that are possible on wide, variable-width medians. Considerable latitude in treatment is intended, provided the requirements of minimum geometrics, safety, and aesthetics are met or exceeded. Unnecessary clearing, grubbing, and grading are undesirable within wide medians. Give preference to selective thinning and limited reshaping of the natural ground. For median clear zone requirements, see Chapter 700, and for slopes into the face of traffic barriers, see Chapter 710.

In areas where land is expensive, make an economic comparison of wide medians to narrow medians with their barrier requirements. Consider right of way, construction, maintenance, and accident costs. The widths of medians need not be uniform. Make the transition between median widths as long as feasible. (See Chapter 620 for minimum taper lengths.)

When using concrete barriers in depressed medians or on curves, provide for surface drainage on both sides of the barrier. The transverse notches in the base of precast concrete barrier are not intended to be used as a drainage feature, but rather as pick-up points when placing the sections.

640.06 Roadsides

(1) Side Slopes

When designing side slopes, fit the slope selected for any cut or fill into the existing terrain to give a smooth transitional blend from the construction to the existing landscape. Slopes flatter than recommended are desirable, especially within the Design Clear Zone. Slopes not steeper than 4H:1V, with smooth transitions where the slope changes, will provide a reasonable opportunity to recover control of an errant vehicle. Where mowing is contemplated, slopes must not be steeper than 3H:1V. If there will be continuous traffic barrier on a fill slope, and mowing is not contemplated, the slope may be steeper than 3H:1V.

Where unusual geological features or soil conditions exist, treatment of the slopes will depend upon results of a review of the location by the region's Materials Engineer.

With justification, fill slopes steeper than shown in the Fill and Ditch Slope Selection tables in Figures 640-1, 2, 3, and 4b may be used when traffic barrier is installed. Do not install traffic barrier unless a hazard requiring mitigation is present. The steepest slope is determined by the soil conditions. Where favorable soil conditions exist, higher fill slopes may be as steep as 1½H:1V. (See Chapter 700 for clear zone and barrier requirements.)

The Cut Slope Selection tables in Figures 640-1, 2, 3, and 4b are for preliminary estimates or where no other information is available. Design the final slope as recommended in the geotechnical report. Do not disturb existing stable cut slopes just to meet the slopes given in the Cut Slope Selection tables. When an existing slope is to be revised, document the reason for the change.

If borrow is required, consider obtaining it by flattening cut slopes uniformly on one or both sides of the highway. Where considering wasting excess material on an existing embankment slope, consult the region's Materials Engineer to verify that the foundation soil will support the additional material.

In all cases, provide for adequate drainage from the roadway surface and adequate drainage in ditches. (See 640.06(4) for drainage ditches in embankment areas details.)

At locations where vegetated filter areas or detention facilities will be established to improve highway runoff water quality, provide appropriate slope, space, and soil conditions for that purpose. (See the *Highway Runoff Manual* for design criteria and additional guidance.)

Except under guardrail installations, it is desirable to plant and establish low-growing vegetation on all nonpaved roadsides. This type of treatment relies on the placement of a lift of compost or topsoil over base course material in the roadway cross section. Consult with the Area Maintenance Superintendent and the region's Landscape Architect to determine the appropriate configuration of the roadway cross section and soil and plant specifications.

Slope treatment, as shown in the Standard Plans, is required at the top of all roadway cut slopes, except for cuts in solid rock. Unless Class B slope treatment is called for, Class A slope treatment is used. Call for Class B slope treatment where space is limited, such as where right of way is restricted.

(2) Roadway Sections in Rock Cuts

Typical sections for rock cuts, illustrated in Figures 640-7a and 7b, are guides for the design and construction of roadways through rock cuts. Changes in slope or fallout area are recommended when justified. Base the selection of the appropriate sections on an engineering study and the recommendations of the region's Materials Engineer and Landscape Architect. Headquarters (HQ) Materials Lab concurrence is required.

There are two basic design treatments applicable to rock excavation (see Figures 640-7a and 7b). Design A applies to most rock cuts. Design B is a talus slope treatment.

(a) **Design A.** This design is shown in stage development to aid the designer in selecting an appropriate section for site conditions in regard to backslope, probable rockfall, hardness of rock, and so on.

The following guidelines apply to the various stages shown in Figure 640-7a:

- Stage 1 is used where the anticipated quantity of rockfall is small, adequate fallout width can be provided, and the rock slope is ½H:1V or steeper. Controlled blasting is recommended in conjunction with Stage 1 construction.
- Stage 2 is used when a "rocks in the road" problem exists or is anticipated. Consider it on flat slopes where rocks are apt to roll rather than fall.
- Stage 3 represents the full implementation of all protection and safety measures applicable to rock control. Use it only when extreme rockfall conditions exist.

  Show Stage 3 as the ultimate stage for future construction on the Plans, Specifications, and Estimates (PS&E) if there is any possibility that it will be needed.

The use of Stage 2 or 3 alternatives (concrete barrier) is based on the designer's analysis of the particular site. Considerations include maintenance, size and amount of rockfall, probable velocities, availability of materials, ditch capacity, adjacent traffic volumes, distance from traveled lane, and impact severity. Incorporate removable sections in the barrier at approximately 200-foot intervals. Appropriate terminal treatment is required. (See Chapter 710.)

Occasionally the existing ground above the top of the cut is on a slope approximating the design cut slope. The height (H) is to include the existing slope or that portion that can logically be considered part of the cut. The cut slope selected for a project must be that required to effect stability of the existing material.

Benches may be used to increase slope stability; however, the use of benches may alter the design requirements for the sections given in Figure 640-7a.

The necessity for benches as well as their width and vertical spacing, is established only after an evaluation of slope stability. Make benches at least 20 feet wide. Provide access for maintenance equipment to the lowest bench, and to the higher benches if feasible. Greater traffic benefits in the form of added safety, increased horizontal sight distance on curves, and other desirable attributes may be realized from widening a cut rather than benching.

(b) **Design B**. A talus slope treatment is shown in Figure 640-7b. The rock protection fence is placed at any one of the three positions shown, but not in more than one position at a particular location. The exact placement of the rock protection fence in talus slope areas requires considerable judgment and should be determined only after consultation with the region's Materials Engineer.

- **Fence position a** is used when the cliff generates boulders less than 0.25 yd^3 in size, and the length of the slope is greater than 350 feet.
- **Fence position b** is the preferred location for most applications.

- **Fence position c** is used when the cliff generates boulders greater than 0.25 yd^3 in size, regardless of the length of the slope. On short slopes, this may require placing the fence less than 100 feet from the base of the cliff.
- Use of gabions may be considered instead of the rock protection shown in fence position a. However, gabion treatment is considered similar to a wall and therefore requires appropriate face and end protection for safety. (See Chapters 710 and 1130.)

Use of the alternate shoulder barrier is based on the designer's analysis of the particular site. Considerations similar to those given for Design A alternatives apply.

Rock protection treatments other than those described above may be required for cut slopes that have relatively uniform spalling surfaces (consult with the region's Materials Engineer).

(3) Stepped Slopes

Stepped slopes are a construction method intended to promote early establishment of vegetative cover on the slopes. They consist of a series of small horizontal steps or terraces on the face of the cut slope. Soil conditions dictate the feasibility and necessity of stepped slopes. They are to be considered only on the recommendation of the region's Materials Engineer. (See Chapter 510.) Consult the region's landscape personnel for appropriate design and vegetative materials to be used. (See Figure 640-8 for stepped slope design details.)

(4) Drainage Ditches in Embankment Areas

Where it is necessary to locate a drainage ditch adjacent to the toe of a roadway embankment, consider the stability of the embankment. A drainage ditch placed immediately adjacent to the toe of an embankment slope has the effect of increasing the height of the embankment by the depth of the ditch. In cases where the foundation soil is weak, the extra height could result in an embankment failure. As a general rule, the weaker the foundation and the higher the embankment, the farther the ditch should be from the embankment. Consult the region's Materials Engineer for the proper ditch location.

When topographic restrictions exist, consider an enclosed drainage system with appropriate inlets and outlets. Do not steepen slopes to provide lateral clearance from the toe of the slope to the ditch location, thereby necessitating traffic barriers or other protective devices.

Maintenance operations are also facilitated by adequate width between the toe of the slope and an adjacent drainage ditch. Where this type of facility is anticipated, provide sufficient right of way for access to the facility and place the drainage ditch near the right of way line.

Provide for disposition of the drainage collected by ditches in regard to siltation of adjacent property, embankment erosion, and other undesirable effects. This may also apply to top of cut slope ditches.

(5) Bridge End Slopes

Bridge end slopes are determined by several factors, including location, fill height, depth of cut, soil stability, and horizontal and vertical alignment. Close coordination between the HQ Bridge and Structures Office and the region is necessary to ensure proper slope treatment. (See Chapter 1120.)

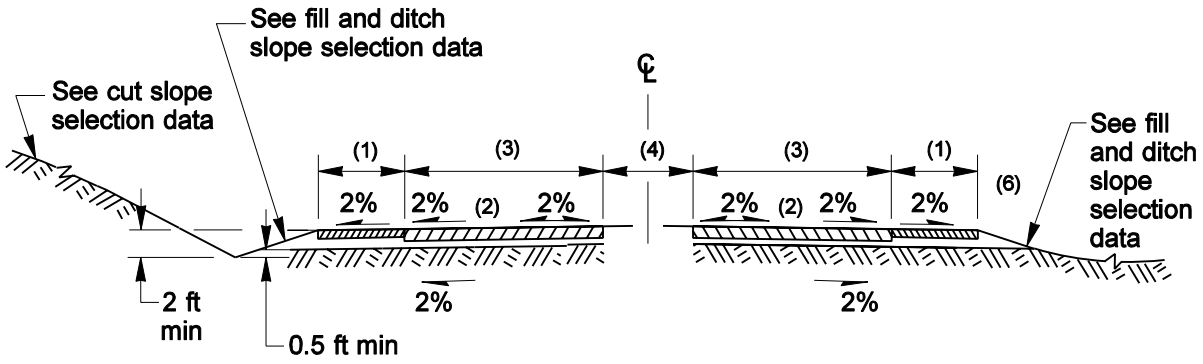
Early in the bridge plan development, determine preliminary bridge geometrics, end slope rates, and toe of slope treatments. Figure 640-9a provides guidelines for use of slope rates and toe of slope treatments for overcrossings. Figure 640-9b shows toe of slope treatments to be used on the various toe conditions.

640.07 Roadway Sections

Provide a typical roadway section for inclusion in the PS&E for each general type used on the main roadway, ramps, detours, and frontage or other roads. (See the *Plans Preparation Manual* for requirements.)

640.08 Documentation

A list of the documents that are to be preserved in the Design Documentation Package (DDP) or the Project File (PF) can be found on the following web site:
http://www.wsdot.wa.gov/eesc/design/projectdev/



Design Class I-1, P-1, P-2, M-1, $U_{M/A}$-1, $U_{M/A}$-2

Height of fill/depth of ditch (ft)	Slope not steeper than (5)
10	6H:1V
10 – 20	4H:1V
20 – 30	3H:1V (6)
over 30	2H:1V (6)(8)

Fill and Ditch Slope Selection

Height of cut (ft)*	Slope not steeper than
0 – 5	6H:1V
5 – 20	3H:1V
over 20	2H:1V (7)
* From bottom of ditch	

Cut Slope Selection (9)

Notes:

(1) For shoulder details, see Figures 640-5a and 5b. For minimum shoulder width, see Chapters 430 and 440.

(2) Generally, the crown slope will be as follows:
- Four-lane highway – Slope all lanes away from the median (plane section).
- Six-lane highway – Slope all lanes away from the median unless high rainfall intensities would indicate otherwise.
- Eight-lane highway – Slope two of the four directional lanes to the right and two to the left unless low rainfall intensities indicate that all four lanes could be sloped away from the median.

(3) For minimum number and width of lanes, see Chapters 430 and 440. For turning roadway width, see Chapter 641.

(4) For median details, see Figures 640-6a through 6c. For minimum median width, see Chapters 430 and 440.

(5) Where practicable, consider flatter slopes for the greater fill heights and ditch depths.

(6) Widen and round foreslopes steeper than 4H:1V, as shown in Figure 640-5b.

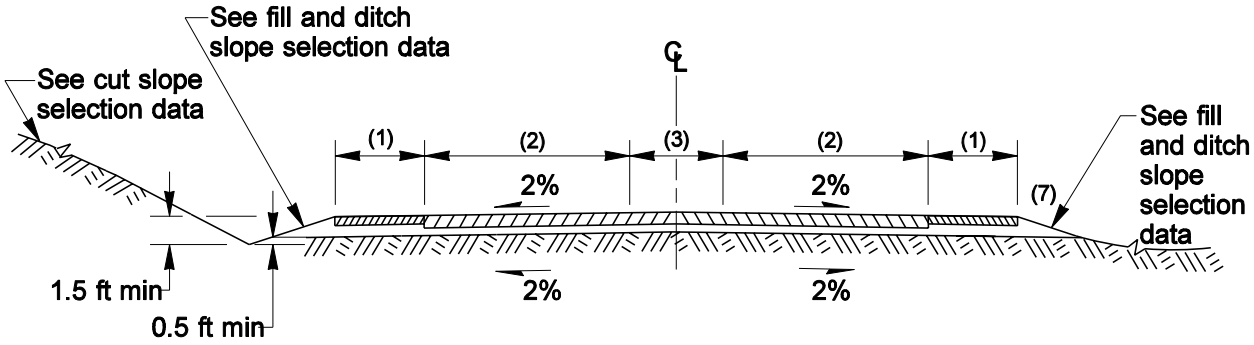
(7) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. (See Chapter 700 for clear zone and barrier requirements.)

(8) Fill slopes as steep as 1½H:1V may be used where favorable soil conditions exist. (See Chapter 700 for clear zone and barrier requirements.)

(9) The Cut Slope Selection table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

Divided Highway Roadway Sections

Figure 640-1



Design Class P-6, M-5, C-1, $U_{M/A}$-3, $U_{M/A}$-4

Height of fill/depth of ditch (ft)	Slope not steeper than (4)
0 – 5	6H:1V
5 – 20	4H:1V
20 – 30	3H:1V (7)
over 30	2H:1V (6)(7)

Fill and Ditch Slope Selection

Height of cut (ft)*	Slope not steeper than
0 – 5	4H:1V
over 5	2H:1V (5)
* From bottom of ditch	

Cut Slope Selection (8)

Notes:

(1) For shoulder details, see Figures 640-5a and 5b. For minimum shoulder width, see Chapters 430 and 440.

(2) For minimum number and width of lanes, see Chapters 430 and 440. For turning roadway width, see Chapter 641.

(3) For minimum median width, see Chapters 430 and 440. For width when median is a two-way left-turn lane, see Chapter 910.

(4) Where practicable, consider flatter slopes for the greater fill heights and ditch depths.

(5) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. (See Chapter 700 for clear zone and barrier requirements.)

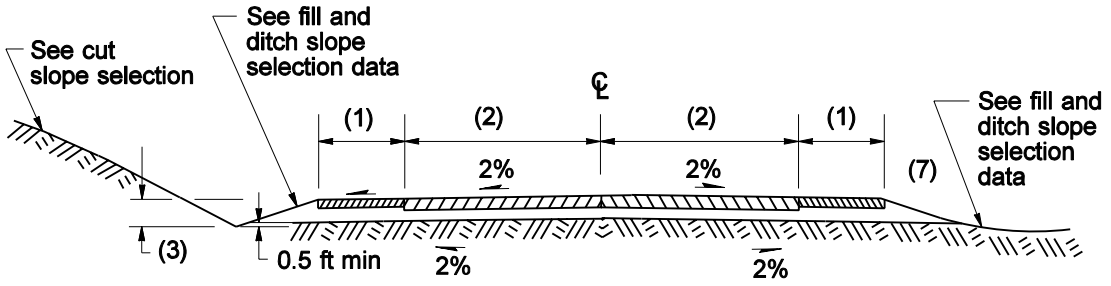
(6) Fill slopes up to 1½H:1V may be used where favorable soil conditions exist. (See Chapter 700 for clear zone and barrier requirements.)

(7) Widen and round foreslopes steeper than 4H:1V, as shown in Figure 640-5b.

(8) The Cut Slope Selection table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

Undivided Multilane Highway Roadway Sections

Figure 640-2



Design Class P-3, P-4, P-5. M-2, M-3, M-4, C-2, C-3, C-4, $U_{M/A}$-5, $U_{M/A}$-6

Design Class of highway	P-3, P-4, M-2, C-2, $U_{M/A}$[5]	P-5, M-3, M-4, C-3, C-4, $U_{M/A}$[6]
Height of fill/ depth of ditch (ft)	Slope not steeper than (4)	
0 – 10	6H:1V	4H:1V
10 – 20	4H:1V	4H:1V
20 – 30	3H:1V (7)	3H:1V (7)
over 30	2H:1V (5)(7)	2H:1V (5)(7)

Fill and Ditch Slope Selection

Design Class of highway	P-3, P-4, M-2, C-2, $U_{M/A}$[5]	P-5, M-3, M-4, C-3, C-4, $U_{M/A}$[6]
Height of cut (ft)*	Slope not steeper than	
0 – 5	6H:1V	4H:1V
5 – 20	3H:1V	2H:1V (6)
over 20	2H:1V (6)	2H:1V (6)
* From bottom of ditch		

Cut Slope Selection (8)

Notes:

(1) For shoulder details, see Figures 640-5a and 5b. For minimum shoulder width, see Chapters 430 and 440.

(2) For minimum width of lanes, see Chapters 430 and 440. For turning roadway width, see Chapter 641.

(3) The minimum ditch depth is 2 feet for Design Class P3 and 1.5 feet for Design Classes P-4, P-5, M-2, M-3, M-4, C-2, C-3, C-4, UM/A-5, and UM/A-6.

(4) Where practicable, consider flatter slopes for the greater fill heights.

(5) Fill slopes up to 1½H:1V may be used where favorable soil conditions exist. (See Chapter 700 for clear zone and barrier requirements.)

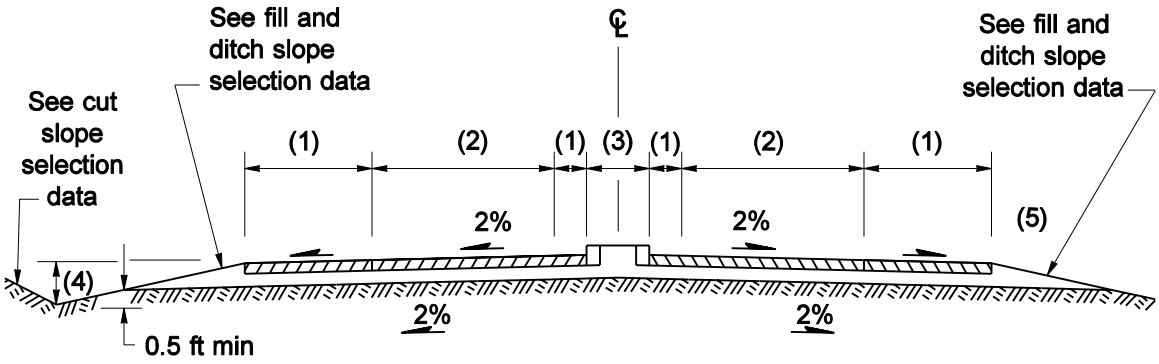
(6) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. (See Chapter 700 for clear zone and barrier requirements.)

(7) Widen and round foreslopes steeper than 4H:1V, as shown in Figure 640-5b.

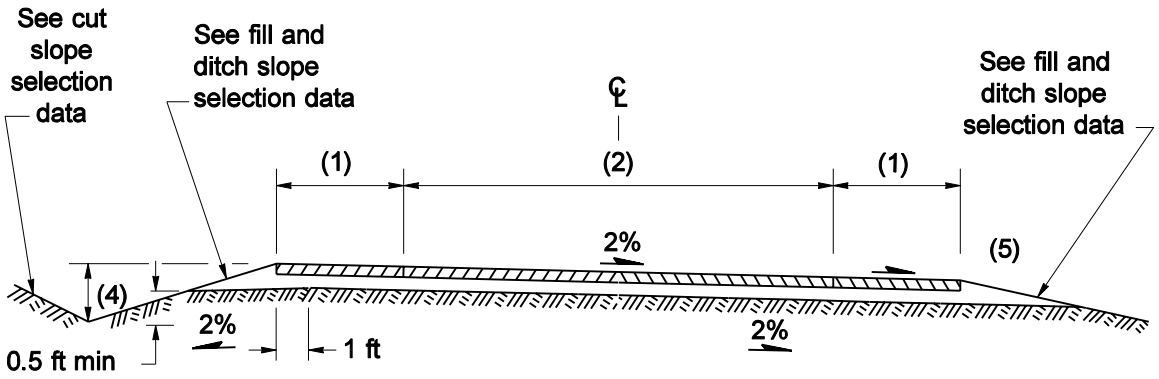
(8) The Cut Slope Selection table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

Two-Lane Highway Roadway Sections

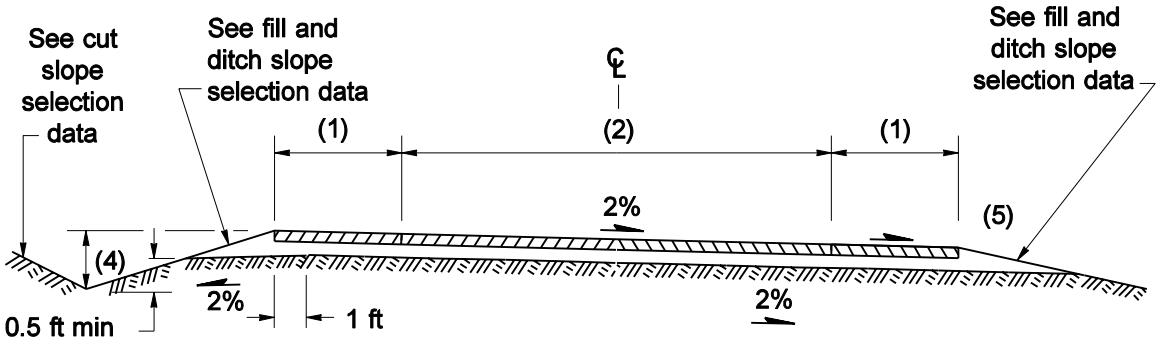
Figure 640-3



Two-Lane Two-Way Ramp



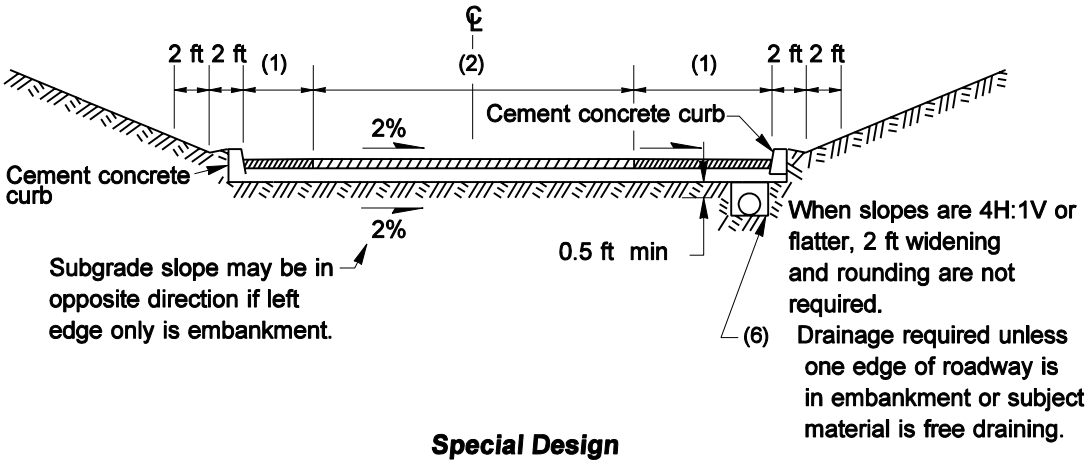
Two-Lane One-Way Ramp



One-Lane Ramp

Note:
For notes, dimensions, and slope selection tables, see Figure 640-4b.

Ramp Roadway Sections
Figure 640-4a



Special Design

This special design section is to be used only when restrictions (high right of way costs or physical features that are difficult or costly to correct) require its consideration.

Height of fill/depth of ditch (ft)	Slope not steeper than (7)
0 – 10	6H:1V
10 – 20	4H:1V
20 – 30	3H:1V (5)
over 30	2H:1V (5) (9)

Fill and Ditch Slope Selection

Height of cut (ft)*	Slope not steeper than
0 – 5	6H:1V
5 – 20	3H:1V
over 20	2H:1V (8)
* From bottom of ditch	

Cut Slope Selection (10)

Notes:

(1) For shoulder details, see Figures 640-5a and 5b. For minimum shoulder widths, see Chapter 940.

(2) For minimum ramp lane widths, see Chapter 940. For turning roadway width, see Chapter 641. For two-way ramps, treat each direction as a separate one-way roadway.

(3) The minimum median width of a two-lane two-way ramp is not less than that required for traffic control devices and their respective clearances.

(4) Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds of 40 mph or less. Rounding may be varied to fit drainage requirements when minimum ditch depth is 2 feet.

(5) Widen and round foreslopes steeper than 4H:1V, as shown in Figure 640-5b.

(6) Method of drainage pickup to be determined by the designer.

(7) Where practicable, consider flatter slopes for the greater fill heights and ditch depths.

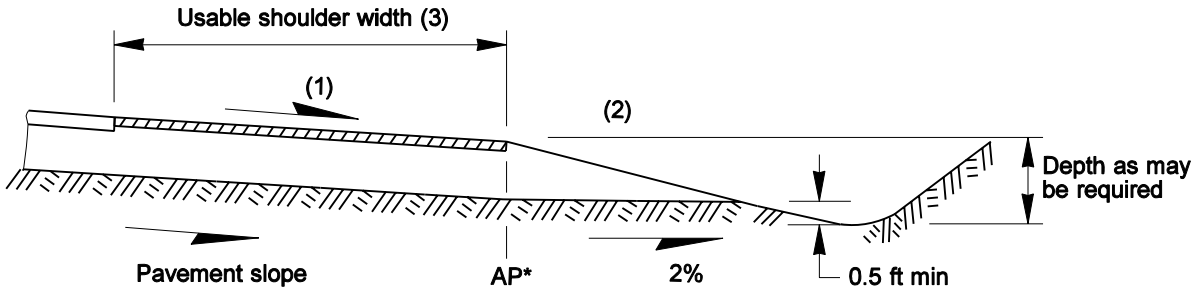
(8) Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. (See Chapter 700 for clear zone and barrier requirements.)

(9) Fill slopes as steep as 1½H:1V may be used where favorable soil conditions exist. (See Chapter 700 for clear zone and barrier requirements.)

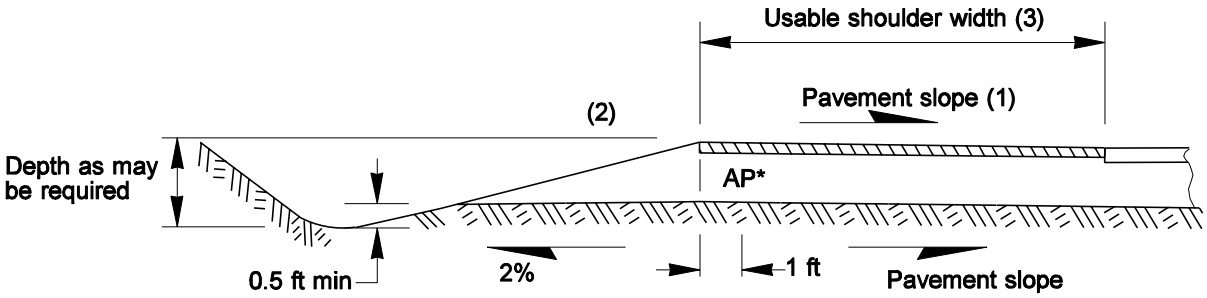
(10) The Cut Slope Selection table is for preliminary estimates or where no other information is available. Design the final slope as recommended in the geotechnical report. Do not disturb existing stable slopes just to meet the slopes given in this table.

Ramp Roadway Sections

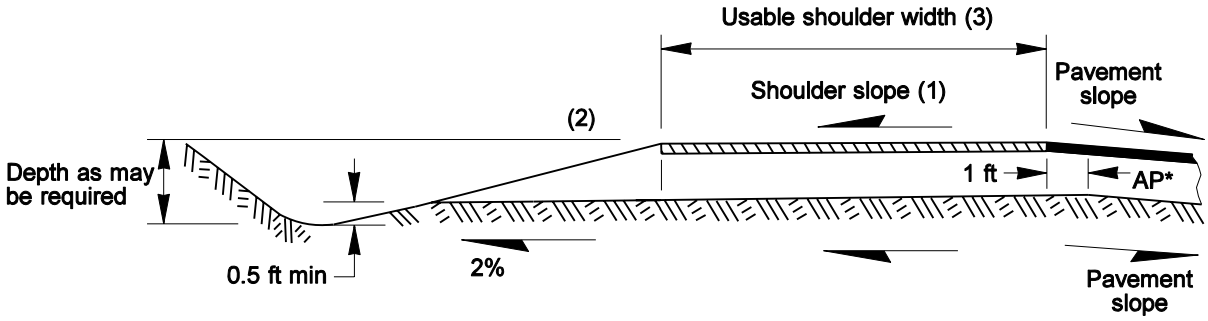
Figure 640-4b



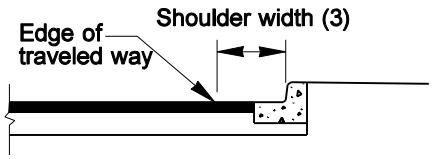
Shoulder Design on the Low Side of the Roadway for Cross Slopes Greater Than 2%.



Shoulder Design on the High Side of the Roadway on Curves and Divided Roadways. Shoulder Slopes With Roadway.



Shoulder Design on the High Side of the Roadway on Curves and Divided Roadways. Shoulder Slopes Away From Roadway.



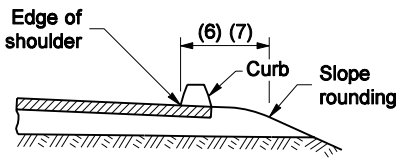
Shoulder Design With Curb (5)(6).

*AP = angle point in the subgrade.

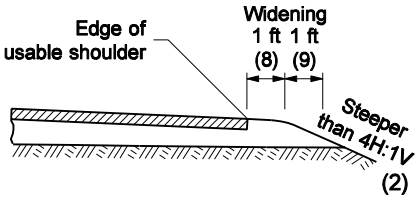
Note:

For notes, see Figure 640-5b.

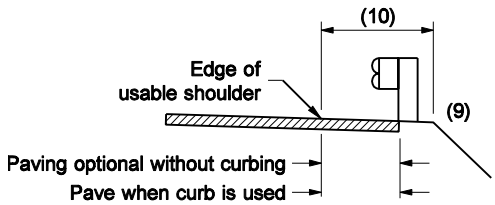
Shoulder Details
Figure 640-5a



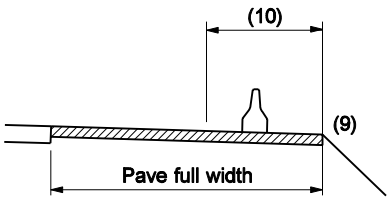
Extruded Curb Placement



Slope Rounding



Shoulder Widening for Guardrail



Shoulder Widening for Barrier

Notes:

(1) Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. (See 640.04(3) in the text for examples, additional information, and requirements of locations where it may be desirable to have a shoulder cross slope different than the adjacent lane.)

(2) Widening and slope rounding outside the usable shoulder is required when foreslope is steeper than 4H:1V.

(3) For minimum shoulder width, see Chapters 430, 440, and 940.

(4) On divided multilane highways, see Figures 640-6a through 6c for additional details and requirements for median shoulders.

(5) For additional requirements for sidewalks, see Chapter 1025.

(6) It is preferred that curb not be used on high-speed facilities (posted speed >40 mph).

(7) Paved shoulders are required wherever extruded curb is placed. Use curb only where necessary to control drainage from roadway runoff. (See the Standard Plans for additional details and dimensions.)

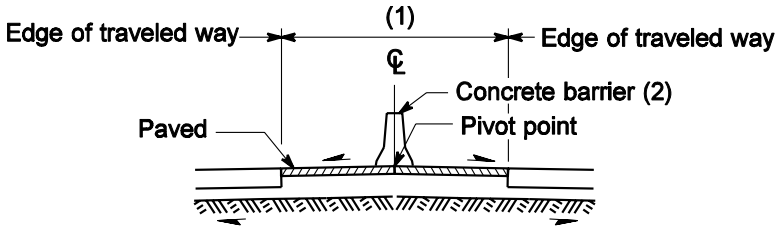
(8) When rounding is required, use it uniformly on all ramps and crossroads, as well as the main roadway. End rounding on the crossroad just beyond the ramp terminals and at a similar location where only a grade separation is involved.

(9) When widening beyond the edge of usable shoulder is required for curb, barrier, or other purposes, additional widening for slope rounding is not required.

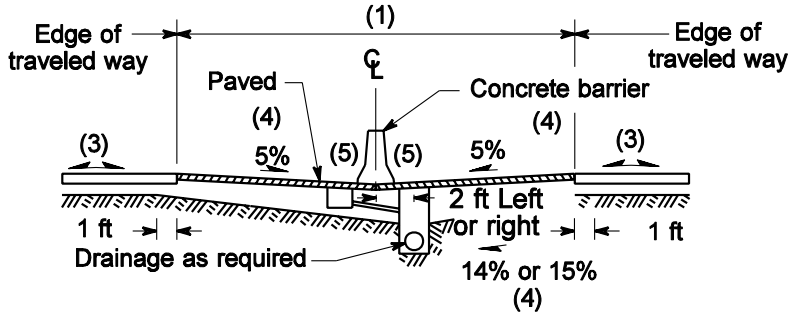
(10) For required widening for guardrail and concrete barrier, see Chapter 710.

Shoulder Details

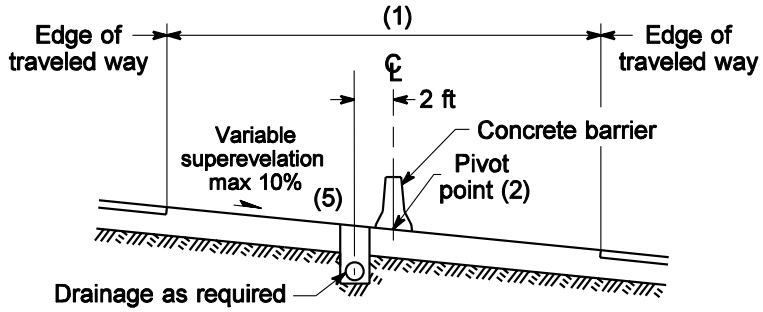
Figure 640-5b



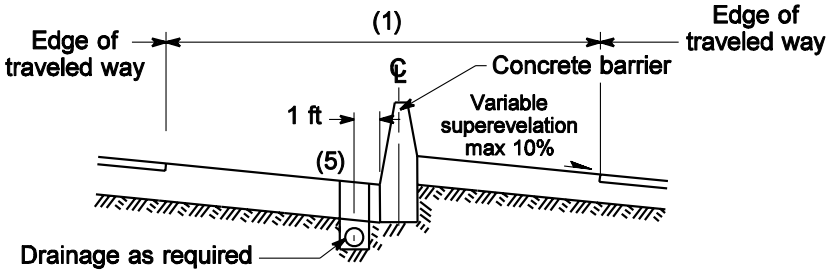
Design A Crowned Median



Design B Depressed Median



Alternate Design 1 Treatment on Curves



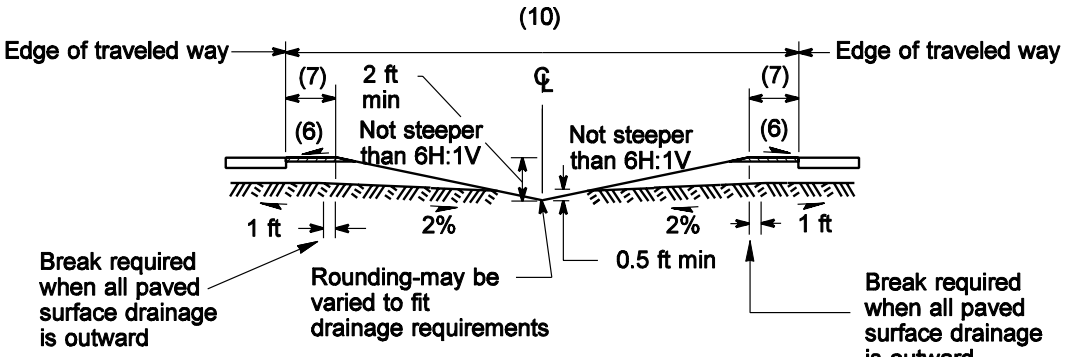
Alternate Design 2 No Fixed Pivot Point (2)

Note:

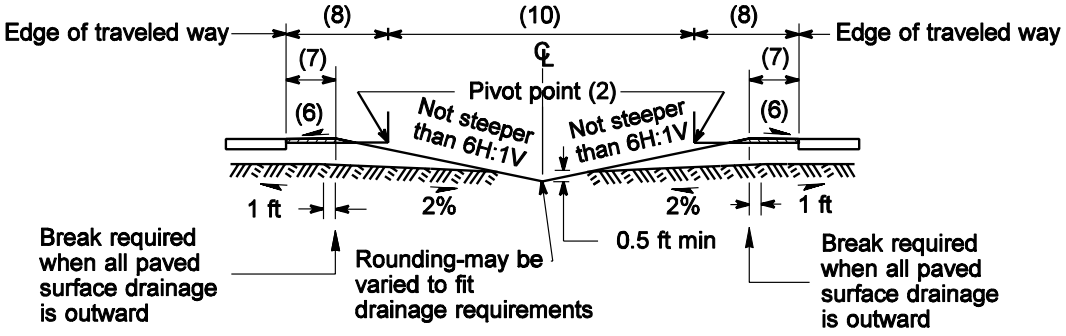
For notes, see Figure 640-6c.

Divided Highway Median Sections

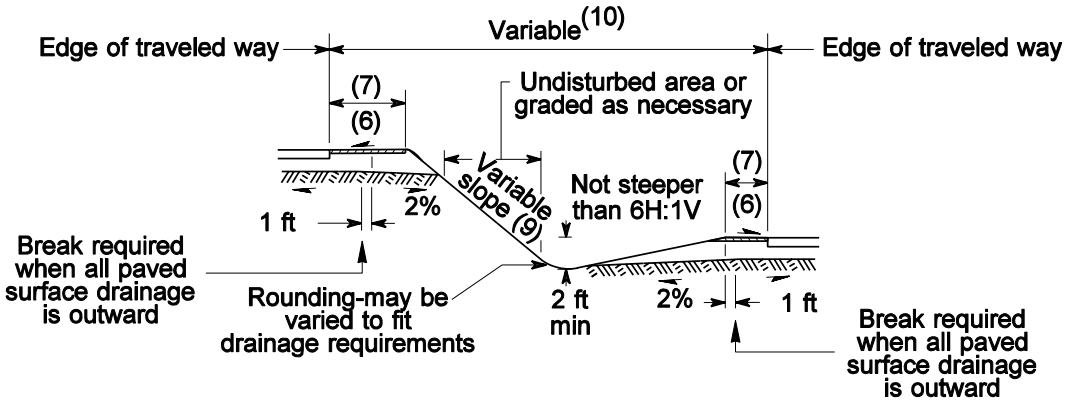
Figure 640-6a



Design C Minimum Nonpaved Median for 4 or More Lanes (2)



Design D Minimum for 4 or More Lanes with Future Lanes in Median



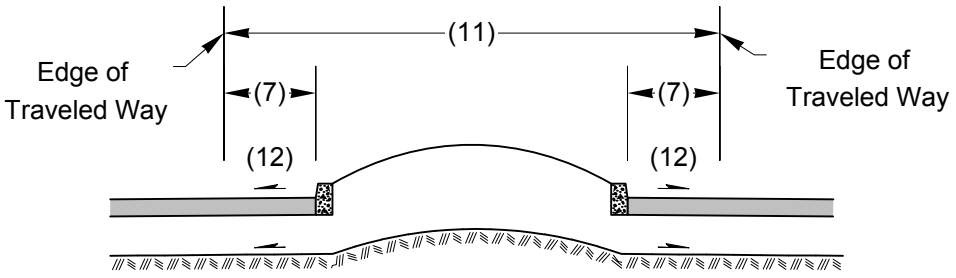
Design E Minimum for 4 or More Lanes with Independent Alignment

Note:

For notes, see Figure 640-6c.

Divided Highway Median Sections

Figure 640-6b



Design F Raised Median (13)

Notes:

(1) For minimum median width, see Chapters 430 and 440.

(2) Locate the pivot point to best suit the requirements of vertical clearances, drainage, and aesthetics.

(3) Pavement slopes generally shall be in a direction away from the median. A crowned roadway section may be used in conjunction with the depressed median where conditions justify. (See Figure 640 1 for additional crown information.)

(4) Design B may be used uniformly on both tangents and horizontal curves. Use alternate designs 1 or 2 when the "rollover" between the shoulder and the inside lane on the high side of a superelevated curve exceeds 8%. Provide suitable transitions at each end of the curve for the various conditions encountered in applying the alternate to the basic median design.

(5) Method of drainage pickup to be determined by the designer.

(6) Median shoulders normally slope in the same direction and rate as the adjacent through lane. (See 640.04(3) for examples, additional information, and requirements of locations where it may be desirable to have a shoulder cross slope different than the adjacent lane.)

(7) For minimum shoulder width, see Chapters 430 and 440.

(8) Future lane (see Chapter 440 for minimum width).

(9) Widen and round foreslopes steeper than 4H:1V, as shown in Figure 640 5b.

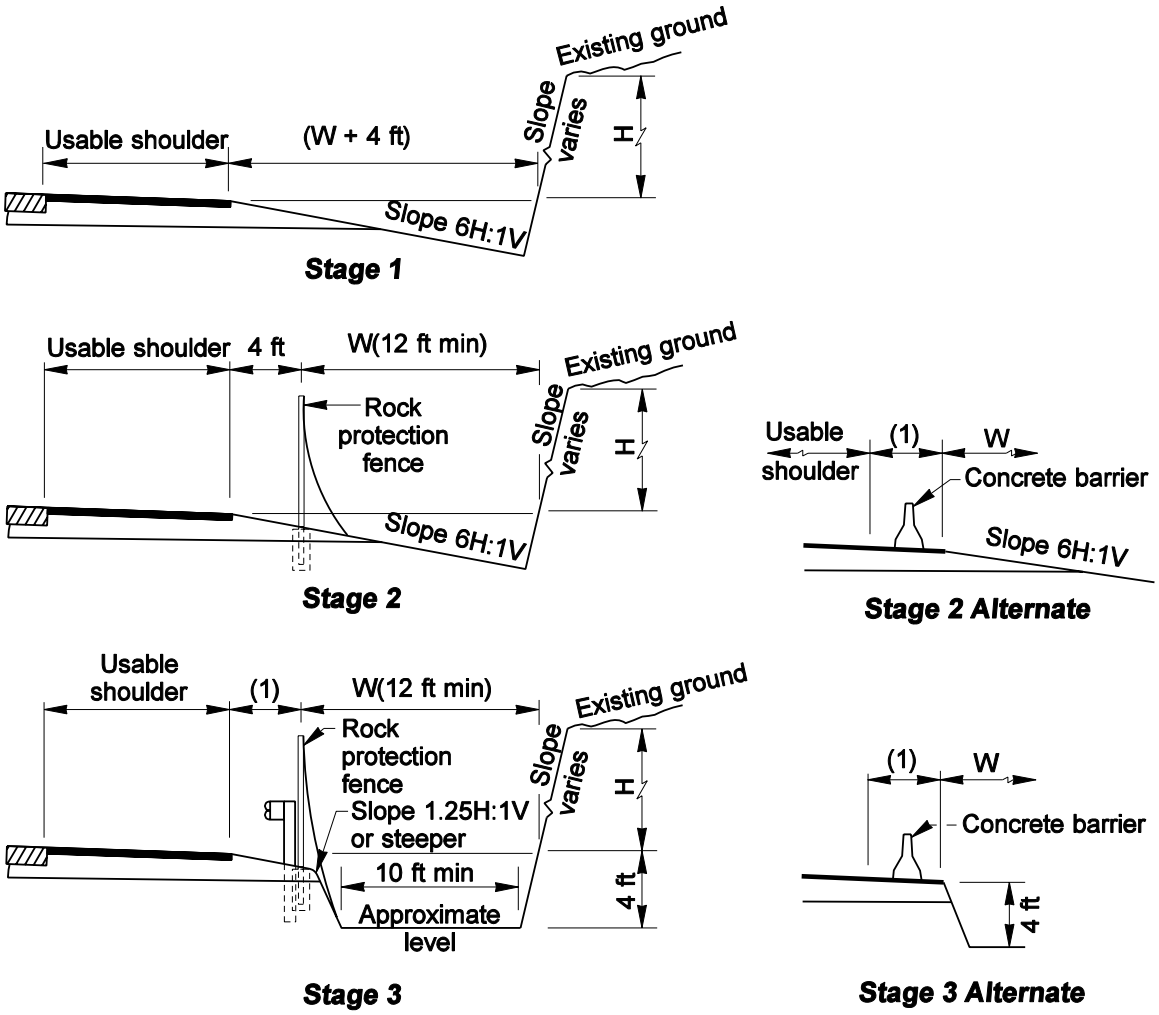
(10) Designs C, D, and E are rural median designs. (See Chapter 440 for minimum rural median widths.) Rural median designs may be used in urban areas when minimum rural median widths can be achieved.

(11) For minimum median width, see Chapter 440. Raised medians may be paved or landscaped. For clear zone and barrier requirements when fixed objects or trees are in the median, see Chapter 700.

(12) Lane and shoulders normally slope away from raised medians. When they slope toward the median, provide for drainage.

(13) The desirable maximum design speed for a raised median is 45 mph. When the design speed is above 45 mph, Design A or Design B is preferred.

Divided Highway Median Sections
Figure 640-6c



Rock Slope	H (ft)	W (ft)
Near Vertical	20-30	12
	30 – 60	15
	> 60	20
0.25H:1V through 0.50H:1V	20-30	12
	30-60	15
	60-100	20
	>100	25

Notes:

Cut heights less than 20 feet shall be treated as a normal roadway, unless otherwise determined by the region's Materials Engineer.

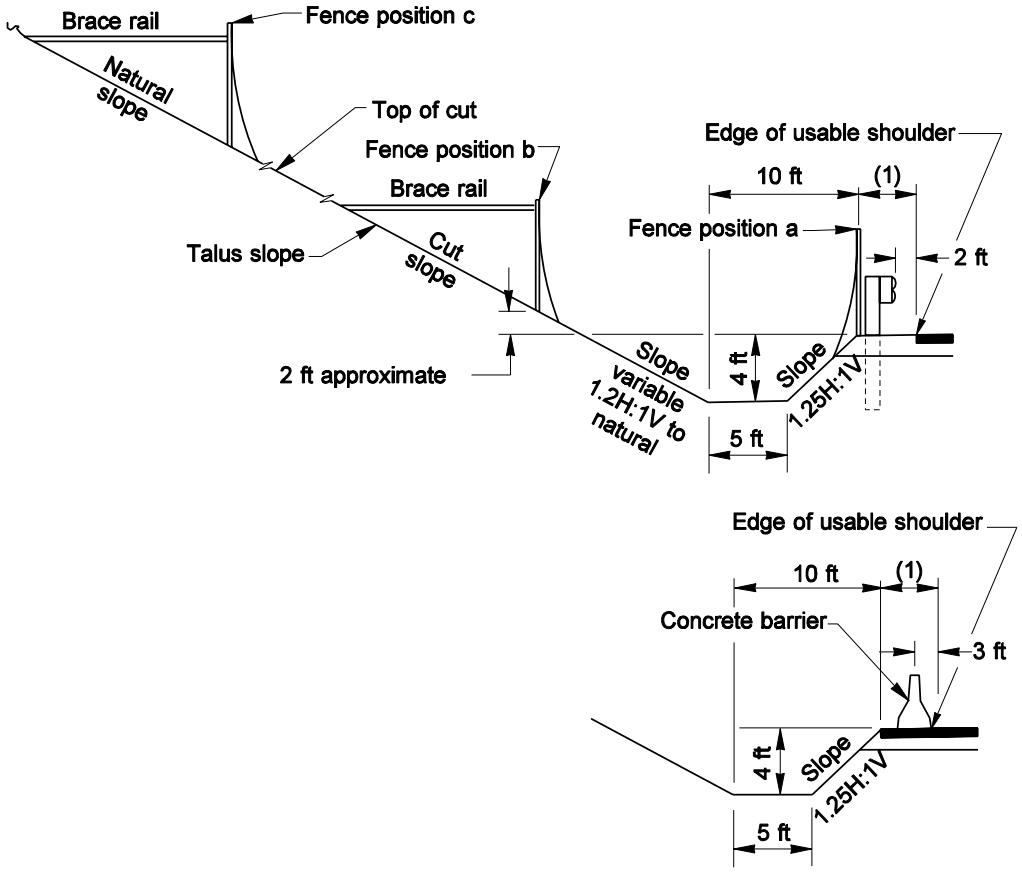
Stage 2 and 3 Alternates may be used when site conditions dictate.

Fence may be used in conjunction with the Stage 3 Alternate. (See Chapter 700 for clear zone requirements.)

(1) For required widening for guardrail and concrete barrier, see Chapter 710.

Roadway Sections in Rock Cuts, Design A

Figure 640-7a



Shoulder Barrier Alternate

Notes:

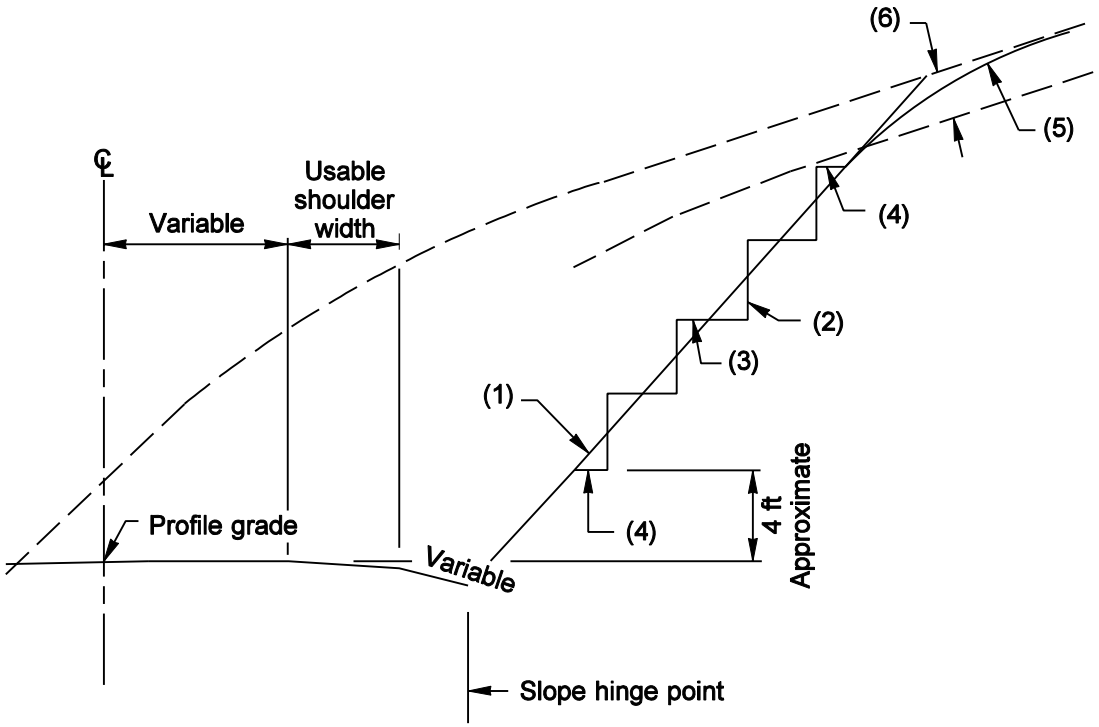
Ordinarily, place fence within a zone of 100 feet to 200 feet maximum from the base of the cliff, measured along the slope.

Rock protection fence may be used in conjunction with the Shoulder Barrier Alternate when site conditions dictate.

(1) For required widening for guardrail and concrete barrier, see Chapter 710.

Roadway Sections in Rock Cuts, Design B

Figure 640-7b



Notes:
(1) Staked slope line – Maximum slope 1H:1V.
(2) Step rise – Height variable 1 foot to 2 feet.
(3) Step tread – Width = staked slope ratio x step rise.
(4) Step termini – Width ½ step tread width.
(5) Slope rounding.
(6) Overburden area – Variable slope ratio.

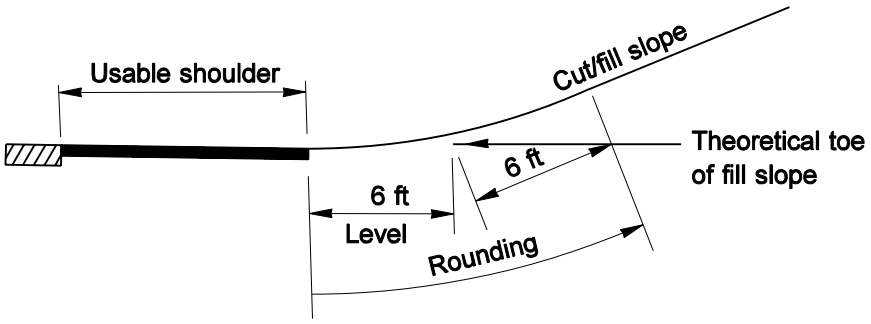
Roadway Sections With Stepped Slopes

Figure 640-8

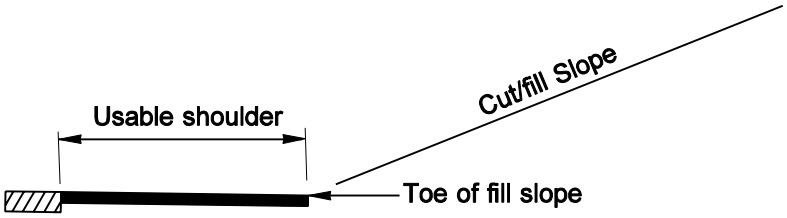
Bridge End Condition	Toe of Slope End Slope Rate		Lower Roadway Treatment (1)		Slope Rate
End Piers on Fill	Height	Rate	Posted speed of lower roadway	Treatment	
	≤ 35 ft > 35 ft	1¾H:1V 2H:1V (2)	> 50 mph ≤ 50 mph	Rounding No rounding	
End Piers in Cut	Match lower roadway slope.(3)		No rounding, toe at centerline of the lower roadway ditch.		(4)
Lower Roadway in Cut	Match lower roadway slope.(3)		No rounding, toe at centerline of the lower roadway ditch.		(4)
Ends in Partial Cut and Fill	When the cut depth is > 5 ft and length is > 100 ft, match cut slope of the lower roadway.		When the cut depth is > 5 ft and length is > 100 ft, no rounding, toe at centerline of the lower roadway ditch.		(4)
	When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designer's choice.		When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designer's choice.		(4)

Notes:
(1) See Figure 640-9b.
(2) Slope may be 1¾H:1V in special cases.
(3) In interchange areas, continuity may require variations.
(4) See 640.06.

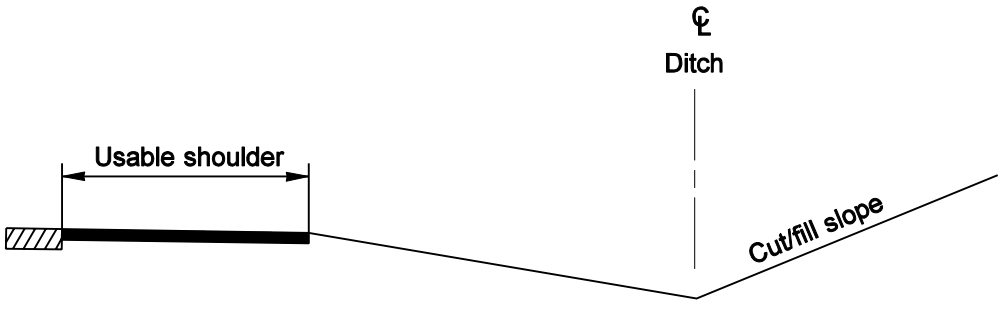
Bridge End Slopes
Figure 640-9a



Rounding



No Rounding



Toe at ℄ of Roadway Ditch

Bridge End Slopes
Figure 640-9b